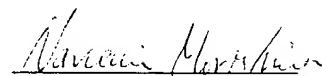


DECLARATION

I, Narumi Morishima, a national of Japan, Excel Nishi-funabashi, RM 210, 566-1, Futago-cho Funabashi, Chiba-ken, Japan, declare that I am familiar with both the English and Japanese languages, that I am the translator of the attached document, that to the best of my knowledge and belief the attached document is a true and accurate translation of Japanese Patent Application No. H9-79422 filed on March 31, 1997, and further that these statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Dated this 23rd day of August, 2002



Narumi Morishima

Patent Application No. H9-79422

[Document] Patent Application

[Ref. Number] 09300140

[Filing Date] March 31, 1997

[Direction] Commissioner of Patent Office

[International Patent Classification] C09J 7/00

[International Patent Classification] H01L 21/60

[Title of the Invention] Circuit-connecting material and method of preparing circuit board

[Number of Claims] 6

[Inventor]

[Address] c/o Tsukuba Research Laboratory, Hitachi Chemical Company, Ltd., 48, Wadai, Tsukuba-shi, Ibaraki-ken

[Name] Touru FUJINAWA

[Inventor]

[Address] c/o Tsukuba Research Laboratory, Hitachi Chemical Company, Ltd., 48, Wadai, Tsukuba-shi, Ibaraki-ken

[Name] Itsuo WATANABE

[Inventor]

[Address] c/o Tsukuba Research Laboratory, Hitachi Chemical Company, Ltd., 48, Wadai, Tsukuba-shi, Ibaraki-ken

[Name] Motohiro ARIFUKU

[Applicant for Patent Application]

[Identification Number] 000004455

[Name] Hitachi Chemical Company, Ltd.

[Representative] Takeshi TANNO

[Agent]

[Identification Number] 100071559

[Patent Attorney]

[Name] Kunihiro Wakabayashi

[Telephone Number] 03-5381-2409

Patent Application No. H9-79422

[Indication of Official Fee]

[Registration Number for Payment in advance] 010043

[Amount of payment] 21,000

[List of Attached Document]

[Document] Specification 1

[Document] Drawings 1

[Document] Abstract 1

[Number of General Power of Attorney] 9005990

[Necessity or not of Proof] Yes

[Document] Specification

[Title of the Invention] Circuit-connecting material and method of preparing circuit board

[Scope of the Claims]

[Claim 1] A circuit-connecting material which is interposed between circuit electrodes facing each other and electrically connects the electrodes in the pressing direction by pressing the facing electrodes against each other, wherein:

said circuit-connecting material comprises as essential components the following components (1) to (3):

(1) a curing agent capable of generating free radicals upon heating;

(2) a hydroxyl-group-containing resin having a molecular weight of 10,000 or more; and

(3) a radical-polymerizable substance.

[Claim 2] The circuit-connecting material according to claim 1, which comprises as essential components conductive particles in addition to the components (1) to (3).

[Claim 3] The circuit-connecting material according to claim 1 or 2, wherein surface of said conductive particle is composed of at least one selected from gold, silver and platinum group metals.

[Claim 4] The circuit-connecting material according to any one of claims 1 to 3, wherein (1) said curing agent capable of generating free radicals upon heating has a 10-hour half-life temperature of 40°C or above and a 1-minute half-life temperature of 180°C or below.

[Claim 5] The circuit-connecting material according to any one of claims 1 to 4, wherein (2) said hydroxyl-group-containing resin having a molecular weight of 10,000 or more has radical-polymerizable functional groups.

[Claim 6] A method of preparing a circuit board which comprises

the following steps of:

disposing a first circuit member having a first connecting terminal and a second circuit member having a second connecting terminal in such a way that the first connecting terminal and the second connecting terminal face each other;

interposing the circuit-connecting material according to any one of claims 1 to 5 between the first connecting terminal and the second connecting terminal which face each other; and

heating and pressing to electrically connect the first connecting terminal and the second connecting terminal which face each other.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a circuit connecting material using an adhesive composition and conductive particles, and a method of preparing a circuit board.

[0002]

[Prior Art]

Epoxy resin adhesives are widely used for various purposes of electric, electronic, construction, automobile, aircraft and so forth because they can attain a high bonding strength and have excellent water resistance and heat resistance. Among them, one-part epoxy resin adhesives are used in the form of films, pastes or powders because they make it unnecessary to mix the base resin and the curing agent and can be used with ease. In this case, it is general to attain specific performances by using epoxy resins, curing agents and modifiers in various combinations (e.g., Japanese Patent Application Laid-open (KOKAI) No. S62-141083).

[0003]

[Problems that the Invention is to Solve]

However, film type adhesives as disclosed in the above Japanese

Patent Application Laid-open (KOKAI) No. S62-141083, though having an excellent operability, have been required to be heated at about 140 to 180°C when connected in a time of about 20 seconds, and at about 180 to 210°C when connected in 10 seconds.

This is because catalyst type curing agents, which are inert at normal temperature, are used so that both short-time curability (rapid curability) and storage stability (storability) can be achieved to attain a better stability, and hence no sufficient reaction can take place when cured.

In recent years, in the field of precision electronic equipment, circuits are being made higher in density, resulting in very small width of electrodes and very narrow spaces between electrodes. Hence, there has been a problem that the wiring comes off, separates or positionally deviates under connecting conditions for circuit-connecting materials making use of conventional epoxy resin adhesives. Also, in order to improve production efficiency, it is increasingly sought to shorten the connecting time to 10 seconds or less, making it indispensable to attain low-temperature rapid curability.

The object of the present invention is to provide an electric and electronic circuit-connecting material having a superior low-temperature rapid curability and also having a longer pot life in comparison with those of the conventional epoxy resin adhesives.

[0004]

[Means of Solving the Problems]

The circuit-connecting material of the present invention is a circuit-connecting material which is interposed between circuit electrodes facing each other and electrically connects the electrodes in the pressing direction by pressing the facing electrodes against each other;

the circuit-connecting material comprising as essential components the following components (1) to (3):

- (1) a curing agent capable of generating free radicals upon heating;

- (2) a hydroxyl-group-containing resin having a molecular weight of 10,000 or more; and
- (3) a radical-polymerizable substance.

In addition to the above components (1) to (3), conductive particles may be contained as the essential component. The conductive particles preferably have its surface composed of at least one selected from gold, silver and platinum group metals.

(1) The curing agent capable of generating free radicals upon heating, which has a 10-hour half-life temperature of 40°C or above and a 1-minute half-life temperature of 180°C or below is used. As (2) the hydroxyl-group-containing resin having a molecular weight of 10,000 or more, which has radically polymerizable functional groups is used.

The method of preparing a circuit board of the present invention comprises the following steps of: disposing a first circuit member having a first connecting terminal and a second circuit member having a second connecting terminal in such a way that the first connecting terminal and the second connecting terminal face each other; interposing the circuit-connecting material described above between the first connecting terminal and the second connecting terminal which face each other; and heating and pressing to electrically connect the first connecting terminal and the second connecting terminal which face each other.

[0005]

[Mode for Carrying Out the Invention]

The curing agent capable of generating free radicals upon heating, used in the present invention, may include peroxide compounds and azo compounds which are capable of being decomposed to generate free radicals upon heating, and may appropriately be selected in accordance with the intended connecting temperature, connecting time, storability or the like. In view of high reactivity and storability, organic peroxides having a 10-hour half-life temperature of 40°C or above and a 1-minute half-life temperature

of 180°C or below are preferred, and organic peroxides having a 10-hour half-life temperature of 60°C or above and a 1-minute half-life temperature of 170°C or below are preferred. The curing agent may be mixed in an amount of from about 0.05 to about 10 % by weight, and preferably from 0.1 to 5 % by weight. Specifically, the curing agent may be selected from diacyl peroxides, peroxydicarbonates, peroxyesters, peroxyketals, dialkyl peroxides and hydroperoxides.

[0006]

The diacyl peroxides may include 2,4-dichlorobenzoyl peroxide, 3,5,5-trimethylhexanoyl peroxide, octanoyl peroxide, lauroyl peroxide, stearoyl peroxide, succinic peroxide, benzoyl peroxytoluene, benzoyl peroxide and the like.

[0007]

The peroxydicarbonates may include di-n-propyl peroxydicarbonate, diisopropyl peroxydicarbonate, bis(4-t-butylcyclohexyl) peroxydicarbonate, di-2-ethoxymethoxyperoxydicarbonate, di(2-ethylhexylperoxy)dicarbonate, dimethoxybutyl peroxydicarbonate, di(3-methyl-3-methoxybutylperoxy)-dicarbonate and the like.

[0008]

The peroxyesters may include 1,1,3,3-tetramethylbutyl peroxyneodecanoate, 1-cyclohexyl-1-methylethyl peroxyneodecanoate, t-hexyl peroxyneodecanoate, t-butyl peroxyphosphate, 1,1,3,3-tetramethylbutyl peroxy-2-ethylhexanoate, 2,5-dimethyl-2,5-di(2-ethylhexanoylperoxy)hexane, 1-cyclohexyl-1-methylethyl peroxy-2-ethylhexanoate, t-hexyl peroxy-2-ethylhexanoate, t-butyl peroxy-2-ethylhexanoate, t-butyl peroxyisobutyrate, 1,1-bis(t-butylperoxy)cyclohexane, t-hexyl peroxyisopropylmonocarbonate, t-butyl peroxy-3,5,5-trimethylhexanoate, t-butyl peroxyaurate, 2,5-dimethyl-2,5-di(m-toluoyleperoxy)hexane, t-butyl peroxyisopropylmonocarbonate, t-butyl peroxy-2-ethylhexylmonocarbonate, t-hexyl peroxybenzoate, t-butyl peroxyacetate and the like.

[0009]

The peroxyketals may include 1,1-bis(t-hexylperoxy)-3,3,5-trimethyl-cyclohexane, 1,1-bis(t-hexylperoxy)cyclohexane, 1,1-bis(t-butylperoxy)-3,3,5-trimethylcyclohexane, 1,1-(t-butylperoxy)cyclododecane, 2,2-bis(t-butyl-peroxy)decane and the like.

[0010]

The dialkyl peroxides may include α , α '-bis(t-butylperoxy)diisopropylbenzene, dicumyl peroxide, 2,5-dimethyl-2,5-di(t-butylperoxy)hexane, t-butylcumyl peroxide and the like.

[0011]

The hydroperoxides may include diisopropylbenzene hydroperoxide, cumene hydroperoxide and the like. Any of these agents capable of generating free radicals may be used alone or in combination, and a decomposition accelerator or inhibitor may be used in combination.

These curing agents coated with a polymeric substance of polyurethane type or polyester type so as to be made into microcapsules are preferred because their pot life can be made longer.

[0012]

The radical-polymerizable substance used in the present invention is a substance having a functional group capable of undergoing radical polymerization, and may include acrylates, methacrylates, maleimide compounds and the like. The radical-polymerizable substance may be used in the state of either of a monomer and an oligomer. Such monomer and oligomer may also be used in combination. As specific examples of the acrylates (methacrylates inclusive), they include methyl acrylate, ethyl acrylate, isopropyl acrylate, isobutyl acrylate, ethylene glycol diacrylate, diethylene glycol diacrylate, trimethylolpropane triacrylate, tetramethylolmethane tetraacrylate, 2-hydroxy-1,3-diacyloxypropane,

2,2-bis[4-(acryloxymethoxy)phenyl]propane,
2,2-bis[4-(acryloxypolyethoxy)phenyl]propane, dicyclopentenyl acrylate,
tricyclo-decanyl acrylate, tris(acryloyloxyethyl) isocyanurate and the like.
Any of these may be used alone or in combination. If necessary, a
polymerization inhibitor such as hydroquinones and methyl ether
hydroquinones may appropriately be used. Also, an instance where the
radical-polymerizable substance has a dicyclopentenyl group and/or a
tricyclodecanyl group and/or a triazine ring is preferred because heat
resistance is improved.

[0013]

As the hydroxyl-group-containing resins of the present invention,
which has a molecular weight of 10,000 or more, may include polymers such
as polyvinyl butyral, polyvinyl formal, polyamide, polyester, phenol resin,
epoxy resin and phenoxy resin, which exhibit superior stress relaxation
properties at the time of curing and bring about an improvement in
adhesion attributable to hydroxyl groups. Those obtained by modifying any
of these polymers with radical-polymerizable functional groups are more
preferred because heat resistance is improved. In such an instance, they
are hydroxyl-group-containing resins having a molecular weight of 10,000 or
more and also radical-polymerizable substances.

These polymers may preferably have a molecular weight of 10,000 or
more, but those having a molecular weight of 1,000,000 or more tend to have
poor mixing properties.

[0014]

The circuit-connecting material may also contain a filler, a softener,
an accelerator, an anti-aging agent, a colorant, a flame retardant, a
thixotropic agent, a coupling agent and a phenol resin, as well as a
melamine resin, a kind of isocyanates and the like.

The material containing a filler can improve connection reliability
and so forth, and is preferred. The filler may be used so long as its

maximum particle diameter is smaller than the particle diameter of the conductive particles, and may preferably be added in an amount ranging from 5 to 60 % by volume. Its addition in an amount more than 60 % by volume may saturate the effect of improving reliability. As the coupling agent, those containing a vinyl group, an acrylic group, an amino group, an epoxy group or an isocyanate group are preferred in view of an improvement of adhesion.

[0015]

The circuit-connecting material of the present invention, even when it does not contain any conductive particles, can achieve connection by bringing the facing circuit electrodes into direct contact when connected, but stabler connection can be achieved in a case where it contains conductive particles. The conductive particles may include particles of metals such as Au, Ag, Ni, Cu and solder or carbon. In order to attain a sufficient storability, they may preferably have surface layers formed of not a transition metal such as Ni or Cu but a noble metal such as Au, Ag or a platinum group metal, and more preferably be formed of Au. Particles comprising a transition metal such as Ni and surface-coated with a noble metal such as Au may also be used. In a case of particles comprising non-conductive, glass or ceramic or plastic and on which the above conductive layers have been formed by coating to provide outermost layers of a noble metal, the particles are deformable upon heating and pressing and hence can have a larger area of contact with electrodes at the time of connection, bringing about an improvement in reliability. Thus, such particles are preferred. Such coat layers of a noble metal may preferably be in a thickness of 100 Å or larger in order to attain a good resistance. However, in a case where layers of a noble metal are provided on particles of a transition metal such as Ni, it may preferably be in a thickness of 300 Å or larger, since free radicals generated by the redox action caused when, e.g., the noble-metal layers come off during the mixing and dispersion of

conductive particles may cause a lowering of storage stability. The conductive particles are used properly in accordance with purposes, within the range of from 0.1 to 30 parts by volume based on 100 parts by volume of the adhesive resin component. In order to prevent adjoining circuits from short-circuiting because of any excess conductive particles, the conductive particles may more preferably be used within the range of from 0.1 to 10 parts by volume.

[0016]

The circuit-connecting material having this composition may also be separated into two or more layers, and separated into a layer containing the curing agent capable of generating free radicals upon heating and a layer containing the conductive particles. In such an instance, it can be improved in storability, in addition to the conventional effect that high-precision property can be obtained.

[0017]

The circuit-connecting material of the present invention is also useful as a film-like adhesive for bonding IC chips to a chip-mounting substrate or for bonding electric circuits mutually.

Description will be made of the connection of electrodes by using the circuit-connecting material obtained by the present invention.

This method is a connecting method of electrodes, which comprises steps of disposing the circuit-connecting material between electrodes facing each other on a circuit board; and achieving connection between the electrodes and adhesion between the circuit boards by heating and pressing. As a circuit board on which electrodes are formed, inorganic substances such as semiconductor, glass and ceramic; organic substances such as polyimide and polycarbonate; and composites of these in combination such as glass/epoxy may be used.

[0018]

The circuit-connecting material of the present invention may still

also be used when semiconductor chips are bonded and fastened to a substrate with an adhesive film by face-down bonding and at the same time electrodes of the both are electrically connected to one another.

More specifically, a first circuit member having first connecting terminals and a second circuit member having second connecting terminals may be disposed in such a way that the first connecting terminals and the second connecting terminals face each other, and the circuit-connecting material (film-like adhesive) of the present invention may be interposed between the first connecting terminals and the second connecting terminals which face each other, followed by heating and pressing to electrically connect the first connecting terminals and the second connecting terminals which face each other.

[0019]

As such circuit members, chip component parts such as semiconductor chips, resistor chips and capacitor chips and substrates such as printed-wiring substrates are used.

Usually, in these circuit members, a large number of connecting terminals (which may be in a singular number as occasion calls) are provided. At least one set of the circuit members are disposed in such a way that at least part of the connecting terminals provided on these circuit members face each other, and the adhesive is interposed between the connecting terminals facing each other, followed by heating and pressing to electrically connect the connecting terminals facing each other.

At least one set of the circuit members is heated and pressed, whereby the connecting terminals facing each other can electrically be connected in direct contact or via conductive particles of an anisotropic conductive adhesive.

[0020]

[Operation]

The present invention can provide an electric and electronic

circuit-connecting material having a superior low-temperature rapid curability and also having a longer pot life in comparison with the conventional epoxy resin types.

[0021]

[Examples]

Now, the present invention will be explained in detail with reference to Examples. Respective mixing ratios are listed in Table 1 as shown in Fig. 1.

Example 1

50 g of phenoxy resin (available from Union Carbide Corp.; trade name: PKHC; average molecular weight: 45,000) was dissolved in a 50/50 (weight ratio) mixed solvent of toluene (boiling point: 110.6°C; SP value: 8.90) and ethyl acetate (boiling point: 77.1°C; SP value: 9.10) to form a solution with a solid content of 40%.

As the radical-polymerizable substance, trihydroxyethyl glycol dimethacrylate (available from Kyoeisha Chemical Co., Ltd.; trade name: 80MFA) was used.

As the free-radical-generating agent, benzoyl peroxide was used.

On the surfaces of polystyrene-core particles, nickel layers of 0.2 μm thick were provided. On the outsides of the nickel layers formed, gold layers of 0.04 μm thick were provided. Thus, conductive particles of 10 μm in average particle diameter were produced.

The phenoxy resin, the trihydroxyethyl glycol dimethacrylate resin and the benzoyl peroxide were formulated in amounts of 50 g, 50 g and 5 g, respectively, in solid weight ratio, and the conductive particles were further mixed and dispersed in an amount of 3 parts by volume based on 100 parts by volume of the adhesive resin component. The resultant dispersion was coated on a fluorine resin film of 80 μm thick by means of a coater, followed by hot-air drying at 70°C for 10 minutes to obtain a circuit-connecting material having an adhesive layer of 35 μm thick. The resultant film-type

adhesive had sufficient flexibility at room temperature, and underwent little change in the film properties after standing at 40°C for 10 hours, showing good storability.

[0022]

Examples 2 and 3

A circuit-connecting material was obtained in the same manner as in Example 1 except that the solid weight ratio of the phenoxy resin/trihydroxyethylglycol dimethacrylate of 50 g/ 50g was set to be 30 g/70 g in Example 2 and 70 g/30 g in Example 3.

[0023]

Example 4

A circuit-connecting material was obtained in the same manner as in Example 1 except that the curing agent was changed from trihydroxyethylglycol dimethacrylate to a 40 % by weight solution of benzoylperoxytoluene in toluene (available from Nippon Oil & Fats Co., Ltd.; trade name: Naiper (phonetically) BMT-T40).

[0024]

Example 5

A circuit-connecting material was obtained in the same manner as in Example 1 except that 40% by weight solution of benzoylperoxytoluene in toluene (available from Nippon Oil & Fats Co., Ltd.; trade name: Naiper (phonetically) BMT-T40) was mixed in an amount of 2 g.

[0025]

Example 6

A circuit-connecting material was obtained in the same manner as in Example 1 except that the curing agent was changed from trihydroxyethylglycol dimethacrylate to a 40 % by weight solution of benzoylperoxytoluene in toluene (available from Nippon Oil & Fats Co., Ltd.; trade name: Naiper (phonetically) BMT-T40).

[0026]

Example 7

A circuit-connecting material was obtained in the same manner as in Example 1 except that the curing agent was changed from trihydroxyethylglycol dimethacrylate to a 50 % by weight solution of t-hexyl peroxy-2-ethylhexanate in DOP (available from Nippon Oil & Fats Co., Ltd.; trade name: Percure (phonetically) HO).

[0027]

Example 8

100 g of phenoxy resin (PKHC) of 45,000 in average molecular weight was allowed to react with 5 g of monoisocyanate terminated with an acrylic group, by a conventional process to produce a phenoxy resin modified with acrylic groups. A circuit-connecting material was obtained in the same manner as in Example 1 except for using this phenoxy resin.

[0028]

Example 9

A circuit-connecting material was obtained in the same manner as in Example 1 except that 0.5 parts by volume of Ni particles having an average particle diameter of 2 μm and surface-coated with Au (coating thickness: 0.08 μm) were used as the conductive particles.

[0029]

Example 10

A circuit-connecting material was obtained in the same manner as in Example 1 except that the conductive particles were replaced with those having particle diameter of 5 μm .

[0030]

Example 11

A circuit-connecting material was obtained in the same manner as in Example 1 except that 30 g of trihydroxyethylglycol dimethacrylate (available from Kyoeisha Chemical Co., Ltd.; trade name: 80MFA) and 20 g of dicyclopentenyl acrylate were used as the radical-polymerizable

substance.

[0031]

Example 12

A circuit-connecting material was obtained in the same manner as in Example 1 except that 30 g of trihydroxyethylglycol dimethacrylate (available from Kyoeisha Chemical Co., Ltd.; trade name: 80MFA) and 20 g of tricyclodecanyl acrylate were used as the radical-polymerizable substance.

[0032]

Example 13

A circuit-connecting material was obtained in the same manner as in Example 1 except that 40 g of trihydroxyethylglycol dimethacrylate (available from Kyoeisha Chemical Co., Ltd.; trade name: 80MFA) and 10 g of tris(acryloyloxyethyl)isocyanulate were used as the radical-polymerizable substance.

[0033]

Example 14

A circuit-connecting material was obtained in the same manner as in Example 1 except that 2,2-bis{4-(acryloxy diethoxy)phenyl}propane (available from Shin-Nakamura Chemical Co., Ltd.; trade name: A-BPE-4) was used as the radical-polymerizable substance.

[0034]

Example 15

A circuit-connecting material was obtained in the same manner as in Example 1 except that the phenoxy resin was changed to a polyvinylbutyral resin (available from Denki Kagaku Kogyo Kabushiki Kaisha, trade name: PVB3000K).

[0035]

Example 16

A circuit-connecting material was obtained in the same manner as in

Example 1 except that 0.5% by volume of Ni particles having an average particle diameter of 2 μm and surface-coated with Pd (coating thickness: 0.04 μm) were used as the conductive particles.

[0036]

Example 17

A circuit-connecting material was obtained in the same manner as in Example 1 except that no conductive particle was used.

[0037]

Comparative Example 1

A circuit-connecting material was obtained in the same manner as in Example 1 except that the curing agent was changed to di-t-butyl peroxide.

[0038]

Comparative Example 2

A circuit-connecting material was obtained in the same manner as in Example 1 except that the curing agent was changed to isobutyl peroxide.

[0039]

Comparative Example 3

A circuit-connecting material was obtained in the same manner as in Example 1 except that the conductive particles were changed to Ni particles with an average particle diameter of 2 μm .

[0040]

Comparative Example 4

A circuit-connecting material was obtained in the same manner as in Example 10 except that the Au plating layer of the conductive particles was changed in a thickness of 0.02 μm .

[0041]

Connection of circuits

Using the above circuit-connecting materials, flexible printed circuit boards (FPCs) each having 500 lines of copper circuits of 50 μm in line width, 100 μm pitch and 18 μm thick were connected to each other over a

width of 2 mm while heating and pressing them at 160°C and 3 MPa for 10 seconds. At this time, the circuits were connected by putting the adhesive surface of the circuit-connecting material on the one FPC, followed by heating and pressing at 70°C and 5 MPa for 5 seconds to make provisional connection, and thereafter peeling the fluorine resin film and connecting the one FPC to the other FPC.

[0042]

(Measurement of Connection Resistance)

After the circuits were connected, the values of resistance between adjoining circuits of the FPCs having the above connected portion were measured at the initial stage and after keeping for 500 hours in a high-temperature high-humidity chamber of 85°C and 85%RH with a multimeter. The resistance values were indicated as an average ($\bar{x} + 3\sigma$) of resistance at 150 spots between adjoining circuits. The circuit-connecting material obtained in Example 1 exhibited a good connection reliability. It was also in a low connection resistance at the initial stage and in an only slightly higher resistance after the high-temperature high-humidity test, showing a high durability. The same good reliability as that in Example 1 was also attained in Examples 2 to 16. The circuit-connecting material obtained in Example 17 had slightly higher connection resistance at the initial stage and slightly higher resistance after the high-temperature high-humidity test because of using no conductive particles. Further, in any cases, the circuit-connecting materials had good storability at room temperature for 10 days or more. In contrast to these, in Comparative Example 1, the curing agent used had low reactivity and though the storability was as long as 10 days or more at room temperature, the bonding was in a poor state because of an insufficient curing reaction, resulting in a high connection resistance at the initial stage. Further, in Comparative Example 2, the curing agent used had very high reactivity, thereby obtaining good connection at the initial stage but the storability was as

short as one day. Further, in Comparative Example 3, good connection was obtained due to the redox action since the Ni particles used were a transition metal, but the storability was as short as one day. Furthermore, in Comparative Example 4, the storability was short in the same as Comparative Example 3 because the gold plating layer was too thin.

[0043]

(Measurement of Adhesive Force)

After the circuits were connected, adhesive force was measured by 90-degree peeling at a peel rate of 50 mm/minute. In Comparative Examples 1 to 4, the adhesive force was as low as about 200 gf/cm in bonding strength. In Examples 1 to 16, an adhesive force of as good as about 1,000 gf/cm was attained.

[0044]

[Effect of the Invention]

As described above, the present invention makes it possible to provide an electric and electronic circuit-connecting material having a low-temperature curability superior to, and a longer pot life than, those of conventional epoxy resin types.

[Brief Description of Drawings]

[Fig. 1] is a table showing results of measurement for adhesive force and connection resistance in the connecting part in Examples and Comparative Examples.

[Document] Drawings

[Fig. 1]

No.	Storage at room temperature for less than one day				Storage at room temperature for 10 days				Storage stability at room temperature
	Resistance (Ω)			Adhesive force (N/m)	Resistance (Ω)			Adhesive force (N/m)	
	Initial stage	500 hrs past	500 hrs past		Initial stage	500 hrs past	500 hrs past		
Example 1	0.03	0.04	1000	0.04	0.04	1000	10 Days or more		
Example 2	0.03	0.04	1100	0.03	0.04	980	10 Days or more		
Example 3	0.04	0.05	1000	0.03	0.04	1000	10 Days or more		
Example 4	0.03	0.03	980	0.04	0.05	1050	10 Days or more		
Example 5	0.03	0.03	1000	0.03	0.03	1000	10 Days or more		
Example 6	0.03	0.03	1050	0.03	0.03	1100	10 Days or more		
Example 7	0.04	0.04	950	0.03	0.03	1000	10 Days or more		
Example 8	0.03	0.03	1000	0.04	0.04	980	10 Days or more		
Example 9	0.03	0.04	900	0.03	0.03	1000	10 Days or more		
Example 10	0.04	0.04	1000	0.03	0.04	1050	10 Days or more		
Example 11	0.03	0.03	1100	0.04	0.04	950	10 Days or more		
Example 12	0.03	0.04	1000	0.03	0.03	1000	10 Days or more		
Example 13	0.04	0.04	980	0.03	0.04	900	10 Days or more		
Example 14	0.04	0.05	1000	0.04	0.04	1000	10 Days or more		
Example 15	0.03	0.03	1050	0.04	0.05	1100	10 Days or more		
Example 16	0.03	0.04	950	0.03	0.03	980	10 Days or more		
Example 17	0.06	0.11	1000	0.07	0.14	1000	10 Days or more		
Comparative Example 1	33	>100	200	27	>100	180	10 Days or more		
Comparative Example 2	0.03	0.05	800	Not conducted	.	100	Less than one day		
Comparative Example 3	0.04	0.04	900	Not conducted	.	100	Less than one day		
Comparative Example 4	0.03	0.04	1000	Not conducted	.	110	Less than one day		

[Document] Abstract

[Abstract]

[Problems] To provide an electric and electronic circuit-connecting material having a low-temperature curability superior to, and a longer pot life than, those of conventional epoxy resin types, which relates to a film-type adhesive which is disposed between electrodes of two circuit boards used in a liquid crystal panel or the like, to obtain good connection between both the electrodes.

[Solution Means] A circuit-connecting material comprising as essential components the following components (1) to (3):

- (1) a curing agent capable of generating free radicals upon heating;
- (2) a hydroxyl-group-containing resin having a molecular weight of 10,000 or more; and
- (3) a radical-polymerizable substance.

[Selected Drawing] None